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PHYSICS.—*Internal pressures in adsorbed films.*[1] P. G. NUTTING, U. S. Geological Survey.

When a vapor or gas is dissolved or adsorbed, there is a perfectly definite relation between concentration or thickness of adsorbed film and external pressure and temperature. Such weight-pressure and weight-temperature curves are readily obtained experimentally, but little progress has been made in their analysis and interpretation. The general problem is of wide interest and importance, for a variety of problems in molecular physics and physical chemistry are but special cases of the general problem, and its solution means the solution of a host of lesser problems. The writer has determined a great number of weight-humidity and weight-temperature curves for the hydrous oxides and silicates and his interest lies in obtaining from these data energies of association and relations between internal and external pressures.

GENERAL PRINCIPLES

When the temperature is uniform throughout any system, the free energy per mole (or per molecule) must also be constant throughout the system, otherwise there would be a net flow of heat from one point to another and this would require a temperature difference. In technical language the thermodynamic potential is everywhere the same. Energy per unit mass times concentration is energy density or energy per unit volume.

When mechanical equilibrium exists throughout any system, the sum of all the pressures normal to any plane is zero. Otherwise there

[1] Received May 14, 1929. Published by permission of the Director of the U. S. Geological Survey.

would be a net drift of material in one direction. In a gas or vapor there are two equal and opposite pressures, the *confining pressure* p inward and the *kinetic pressure* κ outward. In a liquid or solid there are in addition two other pressures, usually very much greater than the two just mentioned, the *cohesion pressure* P and the *contact pressure* π, intensively investigated in recent years by the late T. W. Richards.[2] At equilibrium $p + P = \pi + \kappa$ at every point and in every direction. Besides these four principal pressures others come into play in certain special cases such as solutions. Richards deduced cohesive pressures from compressibilities (β) and thermal expansions (α) using the relation $P = T\alpha/\beta$. I wish to point out some more general and more generally useful methods of arriving at these various pressures.

Since the kinetic pressure is equal to the free (thermal and mechanical) energy density times concentration c, the free energy per mole (RT) is everywhere the same and therefore $\kappa = CJRT/M$ in dynes/cm^2. In other words the kinetic pressure is simply the external or confining pressure corrected for concentration, $\kappa = cp/c_s$ when c_s is the concentration of the vapor phase.

The cohesive pressure is equal to the concentration times the free energy per gram necessary to bring the material to the state or phase in question (latent heat, work of compression, condensation, etc.) from a state (vapor) where it is zero. Therefore, in a liquid,

$$\frac{P}{\kappa} = \frac{q}{RT} = \frac{d \log C_s}{d \log T} \tag{1}$$

a very useful relation since kinetic pressure is so readily determined. If the work done by the cohesive pressure were all done against the kinetic pressure, dP would be equal to $C\,\kappa\,dv = -\kappa\,d \log C$ and therefore $P/\kappa = \log c/c_s = q/RT$, would be a simple relation between change of concentration (from saturated vapor C_s to liquid C) and latent heat (q calories per mole) but the value so computed for water at 26° is only about 0.6 the actual value indicating that 0.4 of the work is done against the distending pressure π.

Equation (1) applies to any liquid in its natural state. If however, heavy external pressures or internal adsorption pressures be applied, the work of compression, the integral of $p\beta dp$ must be added to the latent heat in finding cohesive pressure. In the more general case of

[2] Jour. Am. Chem. Soc. **48**: 3063–80. 1926. Chem. Rev. **2**: 315. 1925. And previous papers.

added pressures capable of doing work, (1) takes the more general form

$$(1a) \qquad \frac{P}{\kappa} = \frac{q}{RT} + \frac{e}{RT} = \frac{d \log C_s}{d \log T} + \int_0^p \frac{d \log C}{d \log p}\, dp$$

where c is the concentration of the liquid affected by the extra pressure p. Similar reasoning applies to solids and the change from liquid to solid. If latent heats (L) are given, the most convenient formula is $P_2 = C_2 L_{12} + C_1 L_{01}$, the subscript 2 referring to the solid and 1 to the liquid state.

These very simple relations between concentration, temperature and the internal kinetic and cohesive pressures cover all ordinary problems in change of phase, obviating the use of an equation of state which after all represents but an illogical attempt to relate the properties of a substance to the external confining pressure. At a free liquid-vapor surface, the surface tension must just equal the kinetic pressure per molecular layer (dynes per cm.). Surface tension may be readily calculated from vapor pressure in this way. Surface energy, $\sigma - Td\sigma/dT$, is easily derived from surface tension σ when its temperature coefficient is known. Osmotic pressure is the increase in cohesive pressure due to dissolved salt hence is $\kappa \log C_s/C$ since it causes a lowering of vapor concentration from saturation C_s to C. At the critical state P and π become zero, $\kappa = p$ and the surface tension drops to zero since the concentration is uniform. Many other simple applications might be cited.

Some numerical data will serve for illustration. For water at 26°C. p = 33590 dynes/cm², v = 40950 cc/gram. The kinetic pressure κ = 1379 megadynes/cm² (from RT), 1375 md/cm² (from p/c) and 1376 (from the external latent heat). The cohesive pressure P = 24340 md/cm² (from the latent heat) or 24360 md/cm² from $P = d \log C_s/d \log T$. By difference, the contact pressure (outward), π = 22970 md/cm². The vapor pressure is quite negligible in comparison with the internal pressures but when large external pressures are applied to a liquid or solid they must be reckoned with the cohesive pressure in computing work done.[3]

Taking for the kinetic pressure of liquid water (C = 1), 1380 megadynes/cm² and multiplying by the molecular diameter 5.2×10^{-8} cm gives for the surface tension 72 dynes/cm. A sulphuric acid-

[3] *Cf.* "Deformation and Temperature," this JOURNAL, March 19, 1929.

water solution 56.1 per cent water (by weight) has a vapor pressure half that of free water hence the cohesive pressure of the water is increased by the H_2SO_4 by $\log 2 = 0.69$ of the kinetic pressure κ, or by 1050 md/cm² which is about 4 per cent of the cohesive pressure of pure water. The osmotic pressure (1050 md/cm²) divided by the concentration of H_2SO_4 (gm/cc) gives the energy of the dissolved acid in ergs/gram, the fundamental variable. In the case just mentioned the acid in solution has about four times as much energy per gram as has the straight acid. In this case, as well as in adsorption, the cohesive pressure represented by $\kappa \log C/C_s$ is an external negative pressure so far as the vapor is concerned hence it operates (on one or more walls) to diminish the confining pressure p.

ADSORPTION AND HUMIDITY

An adsorbed film on a solid is in equilibrium with vapor of concentration C less than saturation C_s. Then $RT \log (C_s/C)$ is the additional external work (in calories/mole) of condensation due to the presence of the solid. This work is due to an increase in cohesive pressure within the film of $\Delta P = \kappa \log (C_s/C)$ where $\kappa = CJRT/M$, C being the concentration of liquid at the outer surface of the film. As the adsorbed film increases in depth, the cohesive pressure decreases rapidly at first then more gradually to that in the pure liquid.

In the case of silica and water the inner layers of adsorbed water are so compressed that the concentration is about 1.3 which corresponds with an additional cohesive pressure of about 17000 atmospheres (1.3 × 1380 megadynes/cm²). This is the equivalent of the "heat of wetting" for an immersed solid[4] and corresponds to a humidity below that given by P_2O_5. Solids which retain water at extremely low humidities may exhibit very high cohesive pressures and at the limit (single layer of molecules), exert chemical forces of actual combination. At the other extreme are salts such as KCl which adsorbs no water until the humidity is above 80 per cent but then adsorbs freely. In this case the maximum cohesive force between salt and water is less than one-fifth ($\log 1/.80$) that normal to pure water. Such a salt will not cake as long as the humidity is held below 80 per cent.

The theory of adsorption of gases does not differ from that given above for vapors but the constants for liquified gases are less well known. However it is more logical, near and above the critical tem-

[4] NUTTING, Jour. Phys. Chem., 31: 531–4. 1927.

perature, to integrate the work done against kinetic pressure. This integration gives for the cohesive pressure due to adsorption $\Delta P = \kappa \log (\kappa / p)$ where p is the gas pressure and $\kappa = CJRT/M$ is the kinetic pressure in the adsorbed film of concentration c gms/cc. Freundlich's equation (quantity adsorbed proportional to a power of the pressure of adsorbed gas or vapor) is consistent with the theory here given as are many other such possible relations, but the falling off of cohesive pressure with depth is only roughly approximated by a logarithmic function.[4] This curve has a rather sharp bend in it and can not be accurately represented by any simple function.

The energy of adsorption in an adsorbed film is readily obtained from experimental data (on weight-humidity). It is the integral of $\Delta P/C$, cohesive pressure due to adsorption over concentration, or

$$E_1 = RT \int_0^z \log (C_s/C) dZ \tag{2}$$

from the solid surface out to a depth Z, in calories/mole/cm.[2]

ADSORPTION AND TEMPERATURE

The effect of a rise in temperature on adsorption is due to several contributing factors; a (slight) decrease in concentration of adsorbed material and a slight decrease in adsorptive forces but chiefly on the first order increase in kinetic pressure and on the large increase of saturation pressure with temperature. Since the cohesive pressure due to adsorption is $P_a = \kappa_s \log (\kappa/p)$, the change $dP_a/dT = dP_a/d\kappa \times d\kappa/dT$ (external vapor pressure p not varying) $= dP_a/dZ \times dZ/dT$ where Z is the film thickness. Carrying out the operations indicated, $dZ/d \log T = dZ/d \log P_s$ or the depth varies with temperature according to the same law as it does with cohesive pressure due to adsorption.

The cohesive pressure at the freezing point and the kinetic pressure at the critical temperature are evidently natural constants of considerable importance for each substance but their discussion is hardly relevant to the subject of this paper.

SUMMARY

Simple thermodynamic definitions of kinetic and cohesive pressures are given, applicable to any homogeneous system in equilibrium.

The simple relations between internal pressures and concentration are pointed out in contrast to equations of state.

The principles developed were applied to the calculation of surface tension directly from vapor pressure.

Cohesive pressures in adsorbed films are shown to be derivable from vapor pressure and from temperature data.

The essential relation between excess cohesive pressure and osmotic pressure was pointed out.

In a later paper the principles here developed will be applied to some weight-temperature and weight-humidity data.

PALEONTOLOGY.—*A fossil ant from the Lower Eocene (Wilcox) of Tennessee.*[1] F. M. CARPENTER. (Communicated by E. W. BERRY.)

Professor E. W. Berry, of the Johns Hopkins University, recently sent me for identification a large ant wing from the Wilcox clays of Tennessee.[2] Since venation is of little value in the taxonomy of the Formicidae, it is quite impossible to determine the exact affinities of this new species. The presence of a discoidal and two cubital cells eliminates it from the Formicidae, to which one might at first be tempted to assign such a large species, and there are, moreover, several structural characteristics so strongly suggestive of the Ponerines that I do not hesitate to place it within this subfamily. The generic affinities, of course, are more obscure. The position of the transverse vein (Tr) at the base of the discoidal cell is similar to that in some genera of Ponerines, mostly within the tribe Ponerini. The first and second cubital cells are much smaller than in any other known ant wing, and the apical side of the first cubital cell is unusually remote from the corresponding side of the second cubital, of which it is generally a continuation. The nearest approach to these conditions is found in the Neotropical *Dinoponera*, and I am inclined to believe that this wing belonged to a species more or less closely related to *Dinoponera*.[3] Such a relationship seems even more probable when we consider that a similar Ponerine genus, closely allied to *Dinoponera* and the South African *Streblognathus*, existed in the Miocene of Florissant, Colorado.[4]

[1] Received May 31, 1929.

[2] Only a few insects, Coleoptra, Trichoptera, and Isoptera, have been described from this formation.

[3] Professor W. M. Wheeler has kindly permitted me to compare this fossil with the ants in his collection, and he also assisted me in making these comparisons.

[4] This Florissant genus is described in my monograph of the fossil ants of North America, now in press (Bulletin Mus. Comp. Zool.).

Eoponera, new genus

Very large ants allied to *Dinoponera*. Fore wing with a small first cubital cell, the apical side joined to the basal part of the stigma; second cubital cell also very short; transverse vein leading to the anal from the base of the discoidal cell.

Genotype: *Eoponera berryi*, new species.

Eoponera berryi, new species

Fig. 1

Represented by the obverse and reverse of a fore wing, 26 mm. long, and 7 mm. wide. The stigma is long and narrow; the discoidal cell is triangular. The apex of the wing is missing, but from the rest of the fossil one would assume that the shape of the complete wing would be much like that of *Myrmecia*.

Holotype: Cat. no. 80825, U. S. N. M. Collected at Puryear, Henry County, Tennessee.

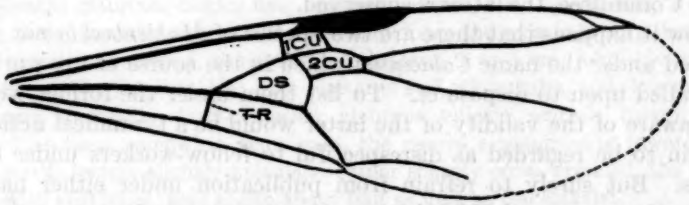

Fig. 1.—Forewing of *Eoponera berryi*, n. sp., from the lower Eocene clays of Tennessee. *1 Cu* and *2 Cu*, first and second cubital cells; *Ds*, discoidal cell; *Tr*, transverse vein.

Although the generic affinities of this species are obscure, it is one of the most interesting fossil ants that has been found. Its great size shows that the complete insect must have had an expanse of at least two and a quarter inches, or 57 mm.! The only known recent ant of such dimensions is *Camponotus* (*Dinomyrmex*) *gigas* (Latr.), of Sumatra and the Malay Peninsula. *Dinoponera grandis* (Guérin) is the largest Ponerine, and although no winged female of this ant seems to exist at present, it is very probable that its queen would be about the same size as that of *E. berryi*. A still more interesting aspect of this new ant is its geological position. Until now the oldest record of the ants has been in the Green River Shale of Utah, Wyoming and Colorado, which is of Middle Eocene age (Auversian). Professor Berry's comprehensive study on the flora of the Wilcox formation has shown that these beds are of Lower Eocene age (Sparnacian-Ypresian), so that this new fossil is the earliest ant that has been found. Strangely enough, the Green River ant-fauna, although not well known seems to be about as highly developed as that existing to-day, and we can only hope that further specimens from the Wilcox beds will be complete enough to throw some light on the origin of the Formicidae.

BOTANY.—*A plea for the conservation of* Muhlenbeckia.[1] J. FRANCIS MACBRIDE, Field Museum of Natural History. (Communicated by PAUL C. STANDLEY.)

In a recent issue of this journal[2] I suggested that obedience to the fundamental provisions of the International Botanical Rules is necessary, if in fact they constitute a document of importance, to be taken seriously. Of course it may be expected that one with any sense of humor or imagination will condone an interpretation of a minor rule to suit the exigency of a given case as the author may feel reason or expediency demands. But surely the Rules, if they have the import of law, must be adhered to literally, in basic principle. For this reason, as already pointed out, the name *Calacinum* Raf. must supplant *Muhlenbeckia* Meissn. unless, by a duly constituted Congress or its Committee, the latter is conserved.

Now it happens that there are two species of *Muhlenbeckia* not yet treated under the name *Calacinum* which in the course of my work I am called upon to dispose of. To list them under the former when well-aware of the validity of the latter would be a tyrannical action, certain to be regarded as disrespectiful to fellow-workers under the Rules. But surely to refrain from publication under either name until a Congress can decide whether to let the law take its course would be honorable and not illegal. Naturally the latter alternative is chosen, since it is now my personal conviction that *Muhlenbeckia* should be conserved. (Though, as a matter of legal routine, I, myself, once restored *Calacinum*.)

It is conceivable that under some circumstances postponement of publication would be inconvenient or impractical, but this can scarcely be the case when a Congress is meeting within a year or two. As a matter of course, if deferment is impossible *Calacinum* would be used by the law-abiding student, even if ultimate conservation of *Muhlenbeckia* should be sought. (I assume that no personal interest in "authorities" would enter into a matter so purely scientific.)

The argument for the conservation of *Muhlenbeckia* can be summed up in a very few words. As no possible interpretation of the Rules can give it legal standing let it be conserved frankly for reasons of sentiment and practicability: because it is well-known in horticulture and because it commemorates the work of a botanist to whom the honor

[1] Received June 10, 1929.

[2] THIS JOURNAL 19: 247. June 19, 1929.

is due. Indiscriminate conservation on such grounds as these is generally to be deplored but surely it would be a desirable and reasonable action in the case of this small genus.

BOTANY.—*Three new grasses from French Sudan.*[1] A. S. HITCHCOCK, Bureau of Plant Industry.

In a collection of grasses from French Sudan submitted for identification by the collector, Dr. O. Hagerup, of the Copenhagen Botanical Museum, the following species appear to be undescribed.

Brachiaria hagerupii Hitchc., sp. nov.

Laminis planis, pubescentibus, 8–15 cm. longis, 8–10 mm. latis; paniculis, angustis, 10–15 cm. longis; ramis appressis, rachi pubescente et hispido; spiculis ellipticis, glabris, 3.5 mm. longis; gluma prima 2 mm. longa.

Sheaths glabrous; blades flat, finely pubescent, 8 to 15 cm. long, 8 to 10 mm. wide; panicles narrow, 10 to 15 cm. long, the axis angled, pubescent, the racemes appressed, somewhat overlapping, 2 to 3 cm. long, the rachis pubescent like the axis, also with scattered stiff white hairs; spikelets mostly in pairs, unequally short-pediceled, glabrous, elliptic, scarcely turgid, narrowed at base, somewhat acuminate, the nerves anastomosing toward the tip; fertile lemma slightly apiculate, rather sharply cross-wrinkled, the pedicels with stiff hairs; first glume about half as long as the spikelet.

Type in the U. S. National Herbarium, no. 1385813, collected at Timbuktu, French Sudan, Africa, August 17, 1927, by O. Hagerup (no. 271).

The specimen shows only the upper part of two culms.

Eragrostis pallescens Hitchc., sp. nov.

Perennis; culmis 60 cm. altis, glabris; vaginis glabris, ore dense piloso; laminis angustis, involutis, glabris, 7–15 cm. longis, longe acuminatis; paniculis pallescentibus, angustis, 15–20 cm. longis, rachi ramisque etiam in axillis glabris; ramis circ. 4 cm. longis; spiculis 5–13 mm. longis, 0.5 mm. latis, 10–30-fl., floribus imbricatis; lemmatibus 1.5 mm. longis, glabris; paleis persistentibus.

Perennial; culms erect from a spreading base, glabrous, about 60 cm. tall; sheaths glabrous, densely pilose at the mouth; blades narrow, involute, glabrous, 7 to 15 cm. long, gradually acuminate to a fine point; panicle narrow, pale, 15 to 20 cm. long, the axis and axils glabrous; branches ascending, about 4 cm. long, the rachis glabrous; spikelets somewhat compressed, closely set, appressed, 5 to 13 mm. long, 0.5 mm. wide, 10 to 30-flowered; lemmas 1.5 mm. long, scaberulous on the keel, imbricate; palea persistent.

Type in the U. S. National Herbarium, no. 1385811, collected at Timbuktu, French Sudan, June 6, 1927, by O. Hagerup (no. 105).

[1] Received June 14, 1929.

Eragrostis albida Hitchc., sp. nov.

Annua; culmis patulis, gracilibus, 15–20 cm. altis; vaginis glabris, ore piloso; laminis angustis, involutis, 1–3 cm. longis; paniculis albescentibus, patulis, oblongis, in axillis glabris, 5–7 cm. longis; ramis 1–3 cm. longis; spiculis appressis, 4–9 mm. longis, 6–15-fl.; lemmatibus 1.5 mm. longis, acutis; paleis persistentibus.

Annual; culms slender, spreading at base, 15 to 20 cm. tall; sheaths glabrous, pilose at the mouth; blades spreading, very narrow, involute, 1 to 3 cm. long; panicle oblong, open, 5 to 7 cm. long, whitish, glabrous in the axils, the branches spreading or ascending, slender, naked below, 1 to 3 cm. long; spikelets appressed and imbricate, 4 to 9 mm. long, somewhat compressed, 6 to 15-flowered; lemmas 1.5 mm. long, narrowed above and acute; palea persistent.

Type specimen in the U. S. National Herbarium, no. 1385812, collected at Timbuktu, French Sudan, June 22, 1927, by O. Hagerup (no. 107).

ETHNOLOGY.—*A point of resemblance between the ball game of the Southeastern Indians and the ball games of Mexico and Central America.*[1] JOHN R. SWANTON, Bureau of American Ethnology.

My studies of the ball game of our Southeastern Indians have brought out a peculiar feature which seems to have had its counterpart in the ball games of the Nahuatl and Maya farther south. There are considerable differences between the game (or games) as played in these two areas, since among the Mexicans and Central Americans ball-courts of stone were especially constructed for it, very few players participated, and no rackets were used, the ball being propelled by striking it with various parts of the body, usually the hips. Indeed, speaking of the Nahuatl game, Zorita says players were compelled to use the hips and if any other part of the body touched the ball the opponents scored a point. The southern game also differed in providing an opportunity to win by a single shot through a hole in a stone midway of the wall. One of these stones was, of course, placed on each side. But this shot was such a difficult one that, although he who made it won, it was unlucky, since it was not attributed to his skill but to some evil or uncanny quality attaching to him. Zorita says that he was regarded as a thief or an adulterer, or one destined to an early death. Therefore, it is evident that games ordinarily turned upon points obtained in the other ways mentioned.

When I came to study the Creek ball game, it struck me as a curious fact that, while the goals were much like our own in lacrosse, to

[1] Received May 15, 1929.

strike one of posts counted as a goal equally with a drive between them. For some unexplained reason the old Choctaw goals were like those of the modern Creeks, whereas the ancient Creek goals and the modern Choctaw goals differ. The latter consist of two planks, four to six inches wide, placed side by side and with no space between. A goal is made by striking the post but the ball must also come to the ground inside of a foul line running through the goal post. The two planks may be the side posts of the goal now brought close together. Before crossbars were used, the Choctaw goal seems to have been formed of two poles set in the ground some distance apart but brought together at the top. The old Creek goal is described as just the reverse of this, made of two poles or withes which diverged at the upper ends, points being scored either by striking the poles or driving the ball over them.

Finally, Du Pratz tells us that the goal of the Natchez game, played annually at the time of the harvest—or rather the new corn—ceremony, were the cabins of the Great Sun and the Head War Chief, and that the game was ended when the ball struck one or the other.

Mention should also be made of the method of scoring in the single pole game, played quite generally throughout the Gulf area. Among the Creeks, men and women usually opposed each other in this game, women driving the ball with their hands while the the men were permitted to use only their sticks. Points were made by striking the pole above a certain mark, and at the very top was a cow skull, a horse skull, or some object made of wood, to hit which scored more than if the pole itself were touched.

On examining methods of making goals among North American tribes having either the single stick game or the two stick game, we find that there are three: (1) hitting a post, reported by three informants out of four from the Chippewa, by one from the Missisauga, one from the Miami, one from the Creeks (Bartram), which is also the present usage of the Choctaw; (2) carrying the ball past a line marked by one post or a line of posts, reported from the Cherokee by one early informant, from the Caughnawaga (probably erroneously), once from the Huron, once from the Dakota, from the Chinook, Pomo, and Miwok; and (3) driving or carrying the ball through a gate, recorded among the Chippewa, among the Thompson Indians, the Dakota, the Iowa, once among the Huron, and among the Mohawk, Seneca, Creeks, and modern Cherokee, and among the Choctaw of an earlier period.

The two last methods appear to be associated more often than is

either with the first. There is a slight suggestion that the first may have had properly a distribution down the Mississippi and this again may have had something to do with the custom spread throughout that area of "striking the post" when announcing successes in war. At any rate two ideas appear to be involved, one scoring by driving the ball past some mark or marks or through some opening, the other scoring by hitting a post or wall, and it is probably significant that, while the goals of the Iroquois, the old time Choctaw, and the modern Creeks were of the two-post type, striking the posts did not count among the Iroquois unless the ball went completely through but it did count with the two Muskhogean tribes. This fact, taken in conjunction with the Natchez usage, leads me to suppose that the goal posts were conceived of in the Southeast as outlining a solid surface. It is in this fact that the resemblance to Mexican systems of scoring appears. The old Creek usage of counting a drive over the posts may be compared with the Mexican usage of counting a drive over the wall.

One difficulty in comparing the ball games of the two areas is presented by the fact that rackets appear to have been unknown to the Mexicans and Middle Americans. However, Bernard Romans informs us that, besides the game with rackets, the Choctaw had a similar game played with a larger ball in which only the hands were employed, and Bushnell shows that this lasted until quite recent times among the Choctaw of Bayou Lacombe, Louisiana, where it was not given up until after the game with ball sticks had been abandoned. The Natchez game also seems to have been played without rackets, and it is possible that they represent an invention of some tribe farther north and east.

Conclusions.—It is believed by most ethnologists who have had occasion to compare the culture of our southeastern Indians with the cultures of the tribes of Mexico and Middle and South America that certain similarities which they present may best be explained by borrowing. Among these may be mentioned head deformation, the use of the blowgun, blackening of the teeth, and probably mounds as the foundation of sacred edifices. There seems to me to be little doubt that the method of scoring points in the ball game, so different from that in vogue among the Iroquoian peoples and among ourselves, is another example of the same thing.

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

989TH MEETING

The 989th meeting was held in the Cosmos Club Auditorium, March 30, 1929.

Program: WARREN W. NICHOLAS, *Structure of the electron.*—It is recalled that the well-known electromagnetic "pulse" theory of X-rays (Stokes, 1897) is in many ways immensely satisfactory when applied to phenomena observed with X-ray continuous spectra. This pulse theory fails, however, to account for the observed spectral energy distribution, the most apparent difficulty being that of accounting for the high frequency limit of the continuous spectrum. Simple experiments are performed with a pendulum (illustrating an oscillator within an atom) which show the manner in which the pulse must affect some atomic oscillators of extremely high frequency; this proves that the pulse would not have a definite high frequency limit, and therefore that the simple pulse theory must be discarded.

It is then shown how this difficulty could be avoided (still retaining all the satisfactory features of the pulse theory) by assuming a more complicated form of pulse; this pulse would be produced by an electron consisting of both positive and negative charge, this charge being distributed over an infinite length along its line of motion according to the formula $\frac{\sin x}{x}$. This would provide for a net negative charge of e as generally accepted, and this electron would account for all the very complicated phenomena so far observed with X-ray continuous spectra.

An extension of the ideas is obtained by supposing that the electron is not of infinite, but of finite, length, of the order of 10^{-7} cm. This finite electron would then not only account for X-ray continuous spectra, but would provide a source for the penetrating cosmic radiation.

It is pointed out that, while the main physical ideas about this electron may be very clear, it is possible that the quantitative relationships may not be expressible in terms of simple mathematical formulae. (*Author's Abstract.*)

W. F. MEGGERS and R. M. LANGER. *Light scattering in liquids.*—In February, 1928, Professor Raman of Calcutta announced the discovery that when monochromatic light is scattered in a transparent pure liquid, the diffused radiation ceases to be monochromatic, in addition to the incident radiation scattered with unmodified wavelength, fainter lines or bands with modified wavelengths appear in the spectrum of the diffused radiation. This new type of radiation immediately attracted much attention and efforts to confirm and extend the observations have been made in a great many laboratories all over the world. The usual experimental arrangement is that first described by Raman and Krishman; it consists of a spherical bulb, filled with liquid, at the center of which the light from a mercury arc is focussed with a condensing lens. The scattered radiation is photographed with small scale prismatic spectrographs with exposures of 25 to 100 or more hours. By using a more efficient arrangement we have been able to reduce the exposures from hours to minutes and even to seconds. The liquid is contained in a cylindrical tube placed parallel and very close to a brilliant quartz-Hg arc. Both are surrounded by cylindrical metal mirrors and the entire system is immersed in running water for temperature control. Scattered radiation passes from the end of the tube directly into the spectrographs. This arrangement, together with the Hilger E_2 spectrograph gives the stronger of the modified lines characteristic of different liquids with exposures of a few minutes, and satisfactory results with a 21-foot concave grating spectrograph have been obtained with exposures of 1 to 2 hours. Spectrograms have been made of Hg light scattered in C_6H_6, CCl_4, $CHCl_3$, H_2O, H_2SO_4, HNO_3, KNO_3, $NaNO_3$, KNO_2, SiO_2 and $CaCO_3$.

The wavelengths of modified radiations have usually been given only two to four figures but it is found that some lines are surprisingly sharp and can be measured to about one part in 300,000. This precision corresponds to about 0.1 cm.$^{-1}$ in wave number, which in turn corresponds to $10^{-4}\mu$ at 3μ or $10^{-3}\mu$ at 30μ.

The first explanation for the modified lines in the spectrum of scattered light was that a molecule may subtract from or add to an incident quantum one of its characteristic energy quanta and scatter the resultant sum or difference in a single quantum. Although only qualitative data were heretofore available, certain difficulties and discrepancies in the correlation of modified lines with infrared absorption bands were apparent. More precise measurements indicate that the frequency shifts may be interpreted not only as absorption frequencies but also as differences between these. If this revised interpretation is correct the significance and power of the experiments with scattered light in unravelling infrared spectra are very much increased. (*Author's Abstract.*)

990TH MEETING

The 990th meeting was held in the Cosmos Club Auditorium, April 13, 1929.

Program: H. A. MARMER, *The Gulf Stream and its problems.*—The prevailing conceptions in regard to the Gulf Stream date back to the conclusions derived about forty years ago, at which time the last of an extensive series of observations was made. Since then, however, our knowledge of many of the

factors involved have undergone considerable modification, and hence the prevailing notions regarding the Gulf Stream must be modified accordingly. The paper discussed the various factors and problems involved. It is to appear in an early issue of the Geographical Review. (*Author's Abstract.*)

F. C. BRECKENRIDGE, *Visibility tests with flashes from neon and incandescent Lamps.*—The visibility of light derived from an incandescent lamp with a red filter has been tested in comparison with that of light from a neon lamp and also with that of a similar incandescent lamp without the filter. Especial attention was given to producing beams having similar candlepower distributions. The tests include a variety of clear, hazy, rainy and foggy weathers and ranges up to 7.0 km.

The results of the test indicate no difference between the visibility of light from a neon lamp and light of the same color and horizontal intensity distribution from incandescent lamp with a filter. The use of the red filter on an incandescent beacon did not increase its visibility under any of the weather conditions encountered, but there was some evidence that it did not reduce the range as much in certain types of foggy or hazy conditions as it did in clear weather.

The neon lamp will produce red light more efficiently than the combination of incandescent lamp and filter. The relatively low brightness and conventional form of the neon lamp, however, are drawbacks for use with lenses and reflectors. The red filter makes the flash more conspicuous and that in many locations more than offsets the loss in range. (*Author's Abstract.*)

F. C. KRACEK, *The polymorphism of sodium sulphate.*—Anhydrous sodium sulphate exhibits complex polymorphism. The behavior of individual samples depends upon their previous thermal history as well as upon their mode of preparation. Heating and cooling curves show radically different individual characteristics. The first heating curve on material crystallized from aqueous solution has six heat absorptions between 195° and 250°. These fall into two major groups; the upper group only is partially reversible on reheating after cooling. The cooling curves always have at least two heat evolutions in close proximity, one of which is the well known arrest at 234°. The thermal evidence combined with microscopic examination leads to the conclusion that this salt is pentamorphic. The three lower forms exhibit pseudomonotropism. None of the inversions are rapid in the dry state, and all show appreciable hysteresis. (*Author's Abstract.*)

991ST MEETING

The 991st meeting was held in the Cosmos Club Auditorium, April 27, 1929. *Program:* JAMES B. MACELWANE, S. J., Professor of Geophysics and Dean of the Graduate School of St. Louis University, by invitation: *Work of the Jesuit Seismological Association.*—It is now just twenty years since the Reverend Frederick L. Odenbach, S. J., of John Carroll University, Cleveland, Ohio, began the movement which has resulted in the present association. February 2, 1909, he addressed a circular letter to the presidents of the Jesuit colleges and universities in the United States and Canada on the possibilities of seismological research. He stressed the advantages of a cooperative program with similar instruments, and told them of the extremely low prices at which the small Wiechert seismographs could be purchased. The result was that in less than two years fifteen institutions purchased horizontal component seismographs. These were Brooklyn College (Brooklyn, N. Y.), Canisius College (Buffalo, N. Y.), Fordham University (New York City),

Georgetown University (Washington, D. C.). Gonzaga University (Spokane, Wash.), Holy Cross College (Worcester, Mass.), John Carroll University (Cleveland, O.), Loyola University (Chicago, Ill.), Loyola University (New Orleans, La.), Marquette University (Milwaukee, Wis.), Regis College (Denver, Colo.), Saint Boniface College (Saint Boniface, Man., Canada), Saint Louis University (Saint Louis, Mo.), Saint Mary's College (Saint Mary's, Kan.), Spring Hill College (Mobile, Ala.), and the University of Santa Clara (Santa Clara, Calif.). Three of these, Georgetown, New Orleans and Santa Clara also purchased vertical component seismographs of the Wiechert type.

The first organization with headquarters in Cleveland under Father Odenbach was called the Jesuit Seismological Service. It worked very well for two years until an unfortunate difference of opinion brought it to a premature end. Left to their own initiative one after another of the stations stopped publishing results or ceased operation altogether. Only Georgetown, Denver, Spring Hill and Saint Louis were still publishing data in 1925. There was danger that the chain of stations as such would prove a wasted effort.

Largely through the initiative of Doctor Arthur L. Day and Mr. Harry O. Wood of the Carnegie Institution of Washington, an exchange of views between the directors, the Jesuit superiors and the speaker was begun in the spring of 1925, which resulted in the formation of the present Jesuit Seismological Association as a voluntary organization of stations, not of men, with a central station at Saint Louis University. The cooperation of Science Service and of the United States Coast and Geodetic Survey, and the proposal made by them to unite with the new association in a plan for the immediate determination of epicenters, helped much in bringing about the reorganization.

Of the twelve stations now in operation, Cincinnati is entirely new and Georgetown, Fordham, Santa Clara and Saint Louis have new, first class equipment. The results so far obtained are highly encouraging, and it is hoped that the presence and activities of these stations in the colleges and universities will lead promising students to take up the study of seismology. (*Author's Abstract.*)

992D MEETING

The 992nd meeting was held in the Cosmos Club Auditorium, May 11, 1929.

Program: HOWARD S. RAPPLEYE: *The mathematical and graphical features of genealogical research.*—This paper represents an informal discussion of certain mathematical and graphical features in connection with the tracing out of family trees and their representation on diagrams of workable size. The mathematical feature of the paper consists almost entirely of a brief discussion of the rate at which the number of ancestors for any given individual increases as one goes backward generation to generation. For the given individual the number of ancestors involved in going back two or three centuries is not beyond the practical limits set by the ability of any one individual to cover the ground, but from that point on the amount of labor involved in looking up double the number of ancestors in each succeeding generation piles up so rapidly as to be entirely out of the question for any individual research.

The portion of the paper dealing with the graphical representation of family trees is illustrated by means of a number of large poster diagrams on which portions of family trees are shown. These illustrate the various types

of diagrams from the simplest or "pedigree diagram" to the more complicated types which attempt to show all of the descendants of some common ancestor. The pedigree type of diagram is useful in tracing the descent of the modern individual to some illustrious ancestor.

The type of diagram on which most emphasis is laid represents at its point a modern individual and attempts to represent all of his ancestors back to the limit of the diagram.

A suggested form of individual record card is also presented with some suggestions as to a convenient numbering system for individual records in the case where the research is covering or attempting to cover the complete ancestry of some present-day individual. (*Author's Abstract.*)

D. B. JUDD: *Recent developments in color theory.*—It is said (Allen) that between 60 and 70 theories of color vision appear in the literature. Of these, the author is somewhat familiar with ten. These theories differ notably with respect to the seat which is chosen for the mechanism that is taken to explain the principal facts of color vision. These facts, for the sake of simplicity in discussion, may be grouped into two heads: (1) the laws of mixture of color stimuli which indicate a system having three degrees of freedom, and (2) the subjectively discovered fact that two pairs of chromatic primaries exist, red and green, yellow and blue. Thus the original Young-Helmholtz theory (still held in different modifications by Tscherning and Allen) spoke of three types of nerve endings in the retina whose various responses (red, green, and violet) were fused in the visual cortex into colors as we experience them. The later Helmholtz view places all three types of response together with their fusions within a single cone-shaped receptor cell of the retina, as does also the Ladd-Franklin view. The theory of Adams assumes three types of receptor cells whose responses are fused by means of synapses within the nerve-tissue layer of the retina itself. The Hering theory which assumes the existence, somewhere in the chain of retinal and post-retinal events, of three reversible processes, red-green, blue-yellow, and black-white, has been rather generally confined by his immediate successors (Tschermak, Müller) to the cortex; but W. T. M. Forbes has recently supplied a possible retinal mechanism based on interference which also yields closely the Hering formulation. Moreover, V. Kries, followed by Schrödinger (of wave-mechanics fame), is inclined to carry on a Young-Helmholtz theory for the retina and a Hering theory for the cortex. All of these various formulations account for the principal facts of color vision; some rather more naturally emphasize the three degrees of freedom of the visual system, others more easily suggest the two pairs of chromatic primaries. The accessory phenomena (after-images, contrast, fatigue, color-blindness, etc.) are judged to be well or ill explained by all these theories depending in large measure on the pre-conceived ideas of the judge.

Recently Selig Hecht has demonstrated that binocular fusion of colors is easy for the normal observer to experience. He indicates that, since this kind of fusion undoubtedly occurs in the cortex, he is inclined to refer all color-fusion to that region. Thus, we may perhaps expect him to return to the original Young-Helmholtz formulation, though, to be sure, of those mentioned only the later Helmholtz, the Ladd-Franklin, and the Adams views refer color-fusion specifically to the retina. Ladd-Franklin has since opposed Hecht's argument by pointing out that his experimental conditions were responsible for the success of his observers with binocular fusion of colors. Rivalry and dominance, rather than fusion, are to be expected for other experimental conditions.

The Ladd-Franklin theory has also been newly attacked by G. E. Müller, who incidentally describes a sort of color deficiency (blue-yellow), lately discovered, which he names Tetartanopia as distinguished from the better known blue-yellow deficiency, Tritanopia. Müller has elaborated the Hering theory by carrying on one Hering formulation for the retina and another (with slightly different primaries) for the cortex. According to this view, Tritanopia is due to the failure of the retinal, blue-yellow process, while Tetartanopia is due to failure of the cortical, blue-yellow process. Müller's views are particularly interesting because experiments at the Bureau of Standards along different lines have independently suggested the need for similar views. (*Author's Abstract.*)

OSCAR S. ADAMS, *Recording Secretary.*

BIOLOGICAL SOCIETY

728TH MEETING

The 728th meeting was held in the new assembly hall of the Cosmos Club January 12, 1929, at 8.10 p.m., with President GOLDMAN in the chair and 70 persons present.

PAUL BARTSCH reported the appearance of the same mocking bird at his feeding shelf for the ninth or tenth year.

HOWARD BALL reported the observation of the following birds: Forster tern near Hunting Creek on 28 December; phoebe, chewink, and catbird on 5 January near Washington; a duck hawk on the post office tower.

Program: P. S. GALTSOFF: *Private life of the American oyster* (illustrated).—An understanding of the factors controlling the life of any organism in the sea requires a thorough knowledge of its physiology and of the seasonal changes that take place in its environment. Such an attempt was made by the author in a study of the life history of the American oyster which because of its wide distribution and abundance plays an important part in the life of our inshore waters.

Quantitative experimental studies on feeding, spawning and sensitivity of the oyster carried out during the last three years at Woods Hole, Mass., enabled the author to describe these activities in the oyster as they occur in nature. It has been found that feeding which consists in filtering of water through the gills and swallowing the microorganisms suspended in water, is controlled by the temperature and ceases entirely at 5°C. The maximum activity of the gills occurs around 25° when the oyster can take in water at the rate of about 4 liters per hour. On a crowded reef millions of gallons of water are filtered daily by the oysters and it happens often that in shallow bays with small range of tides there is not sufficient water available for the oysters which have to live on a reduced diet and starve.

Spawning of the oyster is controlled by the temperature and by the presence of eggs and sperm in the water. The female oyster is unable to spawn at the temperature of 20° or below. Above this temperature limit its spawning can be caused by adding a small amount of sperm to the surrounding water. Spawning reaction is characterized by a long latent period, rythmical contractions of the adductor muscle and discharge of eggs. The reaction is followed by a period of rest which lasts from 2 to 4 days. During this time the oyster is unsusceptible to the sperm. Male oysters can be induced to spawn by adding small amounts of eggs. The reaction takes place almost immediately and consists in the discharge of sperm; it is not accompanied by the contraction of the muscle and is not followed by the period of rest.

Oysters were found to be very sensitive toward slight changes in the chemical composition of sea water, especially to the increase in concentration of potassium salts.

Intimate knowledge of the activities of the organism is essential for understanding the factors that control its life in the ocean. (*Author's abstract.*)

H. F. PRYTHERCH: *Forecasting the time of setting of oysters* (illustrated).—The oyster industry is our most valuable fishery and represents the highest development in the field of agriculture. The oyster lends itself readily to cultivation and the oyster farmer in taking advantage of this has not only made productive thousands of acres of barren bottom in our coastal waters but has increased the production on depleted natural oyster beds from 10 to 100 times. In the waters of Long Island Sound which border the shores of Connecticut we find oyster farming developed to a greater extent than anywhere else in the world. In the past, Connecticut has been famous as a seed oyster producing region and was able to supply the surrounding states and even Europe with this commodity. However, in recent years seed oyster production has decreased to such an extent that the oyster growers have failed to obtain enough seed for the planting of their own grounds and as a result the bottom acreage leased for cultivation has decreased since 1910 from 75,000 acres to 50,000 acres in 1928. The Bureau of Fisheries, in response to requests from the oyster growers, established a field station at Milford, Conn., and proceeded to study (1) the fluctuations in the yield of seed oysters from year to year; (2) the relation between the hydrographic conditions over the oyster beds and these fluctuations; (3) the time of oyster spawning; (4) the occurrence, distribution and behavior of the oyster larvae; and (5) the time of setting or attachment of the oyster larvae to the collecting material that is planted by the oysterman.

I will only have time to discuss briefly the factors that were found to be of greatest importance, as a result of which we have been able to supply the oysterman with advance information as to: (1) Whether there will be a crop of seed oysters and how heavy it will be; (2) when the oysters will spawn; and (3) when setting will occur or in other words, the time by which shell planting should be completed. To arrive at these conclusions over a month in advance, the chief factors that are analyzed are: (1) the quantity of adult oysters and their location; (2) the amount of spawn developed by the oysters; (3) the temperature of the water; and (4) the range of tide.

From a correlation of these factors with the time of spawning and the yield of seed oysters during previous years we have been successful in making predictions for the summers of 1926, 1927 and 1928. The past summer was a rather severe test for forecasting as will be seen from the graphs but fortunately turned out correct and gave additional evidence in support of the method that was employed. The predictions are turned over to the state shellfish commission which issues copies to all the oyster growing concerns which engage in shell planting. (*Author's abstract.*)

G. C. ROUNCEFEL: *Alaska herring investigations.* (No abstract received.)

S. F. BLAKE, *Recording Secretary.*

729TH MEETING

The 729th meeting was held in the new assembly hall of the Cosmos Club January 26, 1929, at 8.10 p.m., with President GOLDMAN in the chair and 55 persons present. New member elected: M. G. NETTING.

FRANK THONE described briefly some new scientific publications.

Mrs. T. M. KNAPPEN reported the recent observation of a towhee in Washington on Tilden Street.

E. P. WALKER: *Some graphic methods of showing problems in wild life administration.*—Due to the failure of the masses of the American public to grasp the problem involved in wild life administration, efforts have been made to present some of them graphically. Four problems were thus presented in diagrams or graphs. The graph of the first subject was based on the premise that a given area of land or water or land and water will support a certain animal population. Increase of the population exhausts the food supply and if the area is not fully stocked there is an economic loss.

The second problem, the fur cycle, illustrated graphically the changes in the value of the skin of a number of land fur-bearing animals, depending upon the dates the animals were killed. This illustrated the growth and priming of the fur until it was at its maximum value for a very short period, and its wearing, fading, and shedding.

The third problem, a basis for adjusting fur seasons, was illustrated with graphs showing relative numbers of animals taken during the first, second, and third months of an open season.

The fourth problem, studies of Alaska fur production, used the three preceding ones for a basis and showed that with the proper adjustment of the seasons for the taking of certain animals a greater cash return can be obtained from a smaller number of animals taken over a short season than from a larger number of animals taken over a longer season; thereby showing the importance of properly adjusting the seasons for taking fur-bearing animals and that such seasons and takes, when properly adjusted and limited, will result in much greater profit than when the seasons are not properly adjusted and the takes thereby limited. (*Author's abstract.*)

O. J. MURIE: *The Alaska caribou* (illustrated).—The caribou occupy the rounded open hills of interior Alaska, although they occur at times in more limited numbers in the high rugged mountains inhabited by the mountain sheep. In summer they feed largely on grasses and herbaceous plants. They are fond of willow in the fall. When snow covers the ground the caribou promptly shift to new feed grounds, seeking the areas where lichens are available. Although lichens are the favorite food in winter, great quantities of grass are also eaten. It is necessary at this time for the animals to paw through the snow with their front feet.

The Indians formerly snared the caribou. A fence several miles long was often built and at frequent intervals a gap was left in which was placed a snare. The caribou, traveling along the fence which they find in their path, encounter an opening and in attempting to pass through, become ensnared. Caribou have been snared in recent years, but the Indians no longer depend on this method of securing game. (*Author's abstract.*)

Professor James G. Needham of Cornell University, spoke of the lack of knowledge of local biology in China. Most of the instruction in the schools and universities seems to refer to animals and plants of the United States or Europe.

730TH MEETING

The 730th meeting was held in the new assembly hall of the Cosmos Club February 9, 1929, at 8.05 p.m., with President GOLDMAN in the chair and 63 persons present.

HOWARD BALL reported the recent observation of the Holboell and horned grebes in the Tidal Basin.

T. S. PALMER: *Some early collectors and recent changes in wild life conditions in the District of Columbia.*—(No abstract received.) Discussed by C. W. STILES.

W. P. TAYLOR: *Important wild life problems in Arizona.*—(No abstract received.) Discussed by T. S. PALMER and C. W. STILES.

The chairman introduced Dr. T. GILBERT PEARSON who announced the passage by both houses of the Game Refuge Bill.

731ST MEETING

The 731st meeting was held in the new assembly hall of the Cosmos Club February 23, 1929, at 8.10 p.m. with President GOLDMAN in the chair and 113 persons present.

The deaths of Dr. FREDERICK A. LUCAS and DR. JONATHAN DWIGHT were announced.

The regular program was as follows:

J. C. MERRIAM: *Opportunities for inspirational education at the Grand Canyon (illustrated).—(No abstract received.)*

VERNON BAILEY: *Present conditions of animal life of the Grand Canyon (illustrated).*—The speaker exhibited lantern slides showing life zones of the general region from the Lower Sonoran Zone in the bottom of the Canyon, the Upper Sonoran Zone of the side slopes and the Painted Desert, the Transition Zone of the plateau top on both sides of the Canyon and around the base of San Francisco Mountain, the Canadian Zone top of the Kaibab Plateau and middle belt of San Francisco Mountain, the Hudsonian Zone at timberline and the Arctic Alpine peaks of the mountains above timberline. The point brought out was that here in a fifty mile section of about 10,000 foot rise in altitude were climatic conditions corresponding to those of a north and south section from the Gulf of Mexico to the Arctic Barren Grounds.

With this wide range of climate a correspondingly great variety of animal and plant life is found and some of the conspicuous species of mammals and reptiles were shown and their zonal ranges discussed. The Grand Canyon as a barrier to distribution was shown by the different species of mammals occurring in the Transition Zone on the two sides at the top separated by the hotter zones below while most of the species of mammals and reptiles of the Lower Sonoran Zone at the bottom of the Canyon occur on both sides of the river. This clearly demonstrates that it is climate and not the river acting as a barrier to keep apart such distinct species as the Abert and Kaibab squirrels, the fulvous and Colorado pocket gophers, and many other mammals on the north and south rims of the Canyon.

Among other animals the mule deer of the Kaibab Plateau were mentioned as of great interest to the thousands of visitors during the summer and lantern slides were shown of some magnificent old bucks with full grown branching antlers. The native mountain sheep and antelope are less numerous but some day it is hoped they will increase to such numbers that they may be seen by all visiting tourists. At present the animal life including at least the mammals, birds, and reptiles, forms a great attraction at the Grand Canyon National Park and these are being protected and encouraged in a way to promise great interest and educational value for future generations. (*Author's abstract.*)

The papers were discussed by C. H. MERRIAM and C. D. MARSH.

A. A. DOOLITTLE, *Recording Secretary pro tem.*

732D MEETING

The 732d meeting was held in the new assembly hall of the Cosmos Club March 9, 1929, at 8.20 p.m., with President GOLDMAN in the chair and 46 persons present. New member elected: C. E. BURT.

Mrs. T. M. KNAPPEN reported the recent observation of thousands of White Ibis in the vicinity of St. Johns River, Florida. Large flocks passed over continuously for about 20 minutes. She also observed a flock of about 200 in Georgia.

A. A. DOOLITTLE reported the observation of a Black-crowned Night Heron in the zoological park during the last week in January.

A. WETMORE reported that the new bird cage at the zoo is practically completed, and that an appropriation of $220,000 is available to build a house for invertebrates and reptiles.

HOWARD BALL gave an account of birds recently observed at Brigantine Beach.

P. B. JOHNSON stated that he had recently seen a muskox at the zoo charging in heavy snow.

The regular program was as follows:

F. C. LINCOLN: *Some causes of bird mortality* (illustrated).—The causes of bird mortality are of interest to every ornithological student. It is axiomatic that there is a large death rate from natural causes and the entrance of man into the picture adds additional hazards to the lives of birds while at the same time removing or controlling others.

Since the bird-banding work was taken over by the Bureau of Biological Survey more than 431,000 birds have been banded, to which may be added 22,500 marked with bands of the old American Bird-Banding Association, giving a grand total of more than 453,600. Of these, return records are available to the number of more than 24,500. Of these returns, 3,156 represent dead birds of the smaller land bird groups and the paper dealt entirely with these, thus eliminating consideration of all birds that are shot as game and others that because of their size are usually victims to gunners.

The number of small banded birds that have been shot was 561, and because of the fact that in most parts of the country blackbirds, starlings, and blue jays are considered as legitimate targets it would seem worth while to subtract the total of such birds from this list, and also the robin, which is still occasionally hunted in southern States. This leaves the insignificant remainder of 57 small song birds that have been shot. The number of small banded birds that have been reported as being killed by cats is 245, which with the exception of shooting is a larger figure than almost all other causes together. This is by far the most serious item on the list, so far overshadowing all other known causes of small bird mortality as to force them entirely into the background.

Banded birds killed by flying into windows, wires, and so forth numbered 67; killed by storms 70; killed by boys with airguns, slingshots, and other juvenile weapons 60; by automobiles and trains, 55; in traps set for other animals 52; by starvation 26; by drowning 19; by being entangled in strings and nesting material 11; by freezing 9; by poison 8; and by collection of scientific specimens 7. The last figure is of peculiar significance when it is recalled that collectors of scientific specimens are frequently accused of destroy-

ing a very large number of small birds. Evidence here presented is, however, seven out of more than 300,000.

Under some miscellaneous causes of death to small birds it is interesting to note that domestic poultry is tied for first place with bronzed and purple grackles. Snakes, bluejays, lawnmowers, seines, golf balls, and various other unusual factors have entered into the death of some of these small banded birds.

It should be borne in mind that a banded bird is literally a marked bird, particularly when in the vicinity of a trapping station, as the neighbors of such a station will consistently coöperate in assisting the operator to keep in contact with birds wearing bands. For this reason a dead bird which when found on the lawn or in the yard of the average home is merely a bit of rubbish to be disposed of as promptly as possible becomes an object to demand attention and if banded to be reported to the station operator or to the Survey. (*Author's abstract.*)

In discussion, A. WETMORE stated that according to his observations the mortality from automobiles was increasing rather than decreasing, apparently due to the general increase in speed. The mortality in early summer appears to be due in part to the large number of young birds and possibly also to the frequency with which birds feed in the road on insects killed at night. C. W. STILES stated that practically all the deaths considered in Mr. LINCOLN's paper were violent deaths and asked what became of the birds that died from the numerous avian diseases, such as cestode, intestinal tuberculosis, avian tuberculosis, avian malaria. Dr. WETMORE replied that the bodies of birds dying either natural or violent deaths were quickly disposed of by other animals.

W. B. BELL: *Present needs in biological research.*—The speaker outlined briefly the general biological field and reviewed some of the outstanding developments in the history of biological sciences which led up to conditions existing at the present time. He stated that the purpose of the discussion was to bring out from people representing divers interests in biological sciences an expression of their views regarding the features which should receive consideration by an organization such as the Biological Society, which represents all lines of biological inquiry and development.

In view of the remarkable expansion in support of biological research during recent years the speaker emphasized the need for planning and organization of research work in such a way that the important fields would be adequately covered, the work so coördinated that accumulated results would represent a well-rounded biological structure and at the same time maintain conditions in research which stimulate individual initiative.

In presenting features in which the speaker was primarily interested emphasis was placed on the importance of thorough study of the natural history and ecological relationships of the vertebrate groups. These should include collection and identification and study of the relationship which the animals sustain under natural conditions to one another and to plant conditions such as forestry, forage, and cultivated crops. A number of pressing problems, including diseases, were mentioned to illustrate the need for thorough study employing the best known technical methods and mechanical equipment in assembling and checking up data which might prove helpful in meeting the present need for constructive action in placing wild life administration on a sound footing. (*Author's abstract.*)

Discussed by C. W. STILES, who summarized the different meanings that had been attributed to the word biology; by VERNON BAILEY, who emphasized our ignorance of the life history of even our most common mammals; and by A. WETMORE, who stressed the need for systematic study in most of the lower groups of animal life.

S. F. BLAKE, *Recording Secretary.*